Takahiro KIMOTO
MOVING PICTURE ENCODING METHOD,
MOVING PICTURE DECODING METHOD...
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FIG. 1

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Sheet 2 of 20
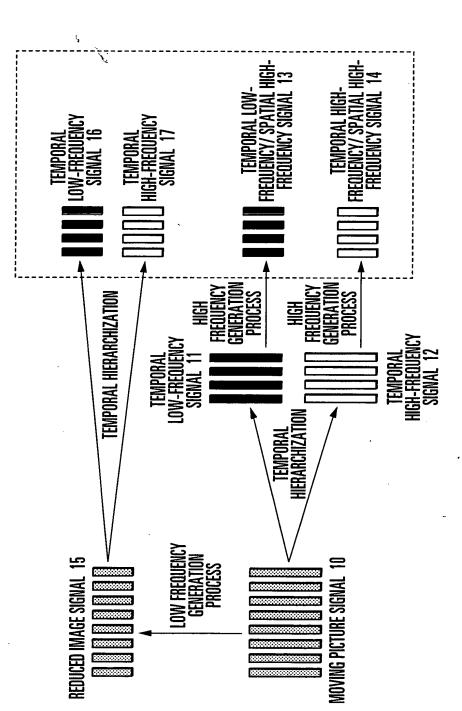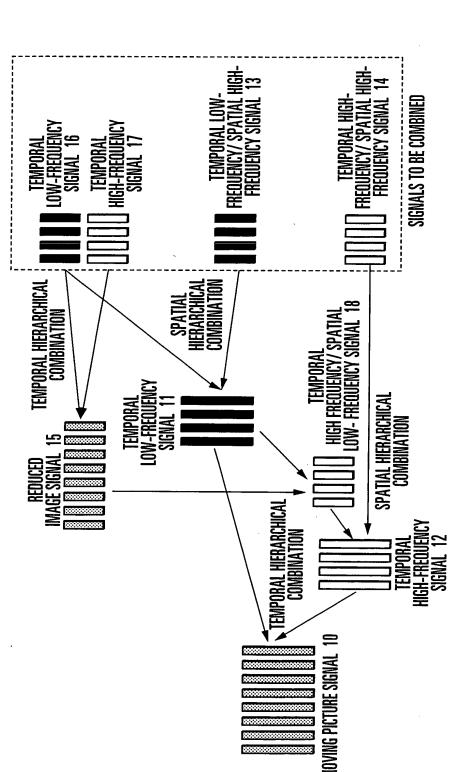
F I G. 2

TEMPORAL LOW-FREQUENCY SIGNAL 16

TEMPORAL HIGH-FREQUENCY SIGNAL 17

TEMPORAL LOW-FREQUENCY/ SPATIAL HIGH-FREQUENCY SIGNAL 13

TEMPORAL HIGH-FREQUENCY/SPATIAL HIGH-FREQUENCY SIGNAL 14

SIGNALS TO BE COMBINED

TEMPORAL HIERARCHICAL COMBINATION

SPATIAL HIERARCHICAL COMBINATION

REDUCED IMAGE SIGNAL 15

TEMPORAL LOW-FREQUENCY SIGNAL 11

TEMPORAL HIGH FREQUENCY/ SPATIAL LOW-FREQUENCY SIGNAL 18

TEMPORAL HIGH-FREQUENCY/SPATIAL LOW-FREQUENCY SIGNAL 12

SPATIAL HIERARCHICAL COMBINATION

TEMPORAL HIERARCHICAL COMBINATION

MOVING PICTURE SIGNAL 10

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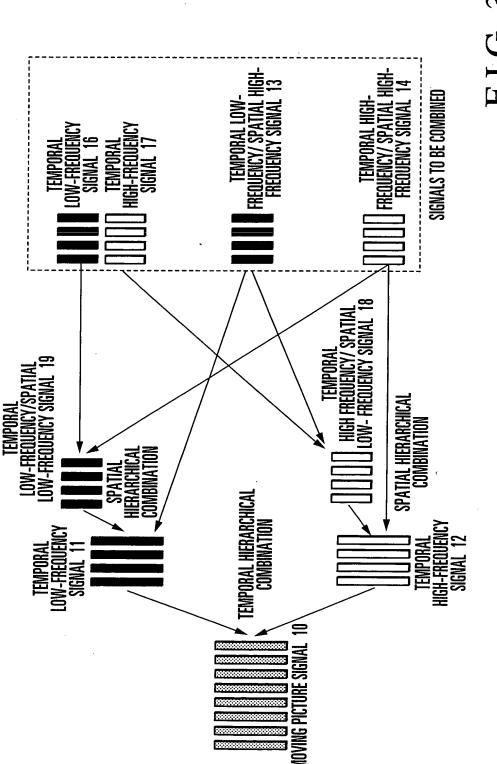SUGHRUE MION, PLLC: 202.293.7060
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FIG. 3

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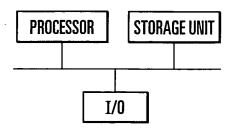SUGHRUE MION, PLLC: 202.293.7060
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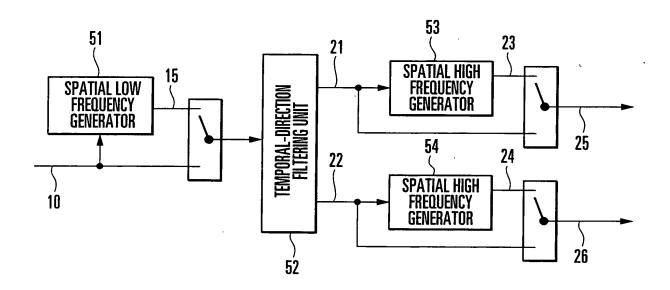| PROCESSOR	STORAGE UNIT

I/O

FIG. 4

51
SPATIAL LOW
FREQUENCY
GENERATOR

15

10

TEMPORAL-DIRECTION
FILTERING UNIT

52

21

53
SPATIAL HIGH
FREQUENCY
GENERATOR

23

25

22

54
SPATIAL HIGH
FREQUENCY
GENERATOR

24

26

FIG. 5

(START)

TEMPORALLY HIERARCHIZE MOVING PICTURE SIGNAL 10 →
GENERATE TEMPORAL LOW-FREQUENCY SIGNAL 11,
TEMPORAL HIGH-FREQUENCY SIGNAL 12 — STEP 80

SPATIALLY HIERARCHIZE TEMPORAL LOW-FREQUENCY SIGNAL 11,
TEMPORAL HIGH-FREQUENCY SIGNAL 12 → GENERATE TEMPORAL
LOW-FREQUENCY/SPATIAL HIGH-FREQUENCY SIGNAL 13,
TEMPORAL HIGH-FREQUENCY/SPATIAL HIGH-FREQUENCY SIGNAL 14 — STEP 81

SPATIALLY HIERARCHIZE MOVING PICTURE SIGNAL 10 →
GENERATE REDUCED IMAGE SIGNAL 15 — STEP 82

TEMPORALLY HIERARCHIZE REDUCED IMAGE SIGNAL 15 →
GENERATE TEMPORAL LOW-FREQUENCY SIGNAL 16,
TEMPORAL HIGH-FREQUENCY SIGNAL 17 — STEP 83

(END)

F I G . 6

START

DEFINE j=0, ORIGINAL IMAGE A[i] AS $A^{(0)}[i]$ $(0 \leq i < n)$ —— 101

i=0 —— 102

SUBBAND DIVIDE $A^{(j)}[i<<j]$ AND $A^{(j)}[(i+1)<<j]$ IN TEMPORAL AND SPATIAL DIRECTIONS → GENERATE $A^{(j)*}[i<<j]$ AND $E*[(i+1)<<j]$ —— 103

104 —— $j=\log 2(n)-1$? YES

NO

j++

108

SUBBAND COMBINE $A^{(j)*}[i<<j]$ IN SPATIAL DIRECTION → GENERATE $A^{(j+1)}[i<<j]$ —— 105

i+=2 —— 106

YES —— $(i<<j)<n$? —— 107

NO

QUANTIZE AND LOSSLESSLY ENCODE $A^{(j)*}[0]$, $E*[i](0<i<n)$ —— 109

END

F I G . 7

```
                    ( START )
                        │
                        ▼
┌─────────────────────────────────────────────┐
│ ESTIMATE MOTION OF B0 WITH RESPECT TO C0      │──── 111
└─────────────────────────────────────────────┘
                        │
                        ▼
┌─────────────────────────────────────────────┐
│ TEMPORALLY SUBBAND DIVIDE B0 WITH RESPECT TO C0│──── 112
│        → GENERATE A0*, E0*                    │
└─────────────────────────────────────────────┘
                        │
                        ▼
┌─────────────────────────────────────────────┐
│ SPATIALLY SUBBAND DIVIDE A0*,E0* BY ONE HIERARCHY│──── 113
│  → GENERATE L(A0*), H(A0*), L(E0*), H(E0*)    │
└─────────────────────────────────────────────┘
                        │
                        ▼
                  ┌──────────┐
                  │   k=1    │──── 114
                  └──────────┘
                        │
                        ▼
┌─────────────────────────────────────────────┐
│ SPATIALLY SUBBAND DIVIDE Bk-1,Ck-1            │──── 115
│  → GENERATE Bk, Ck, H(Bk), H(Ck),            │
└─────────────────────────────────────────────┘
                        │
                        ▼
┌─────────────────────────────────────────────┐
│ TEMPORALLY SUBBAND DIVIDE Bk WITH RESPECT TO Ck│──── 116
│        → GENERATE Ak*, Ek*                    │
└─────────────────────────────────────────────┘
                        │
        117 ─── ◇────────────────◇  YES
    ┌──────┐    │     k=m ?       │──────────┐
    │ k++  │    ◇────────────────◇           │
    └──────┘         │ NO                      │
       │  119        ▼                         │
       │   ┌─────────────────────────────────┐│
       │   │ SPATIALLY SUBBAND DIVIDE Ak*, Ek*││──── 118
       │   │ BY ONE HIERARCHY                 ││
       │   │ → GENERATE L(Ak*),H(Ak*),L(Ek*), ││
       │   │   H(Ek*)                          ││
       │   └─────────────────────────────────┘│
       └──────────────┘                        │
                                               │
                        ┌──────────────────────┘
                        ▼
┌─────────────────────────────────────────────┐
│ OUTPUT Am*, H(Bk), Em*, H(Ek*) AS DIVISION RESULTS│──── 120
└─────────────────────────────────────────────┘
                        │
                        ▼
                    ( END )
```

F I G . 8

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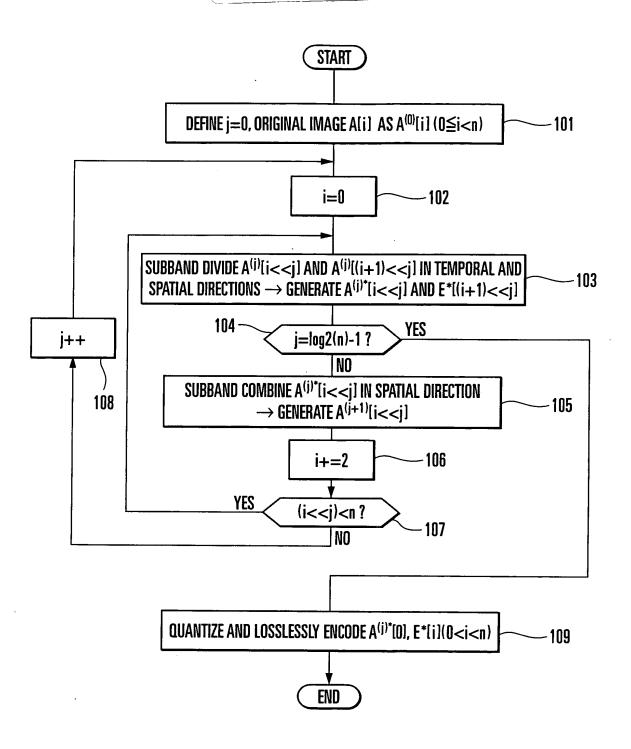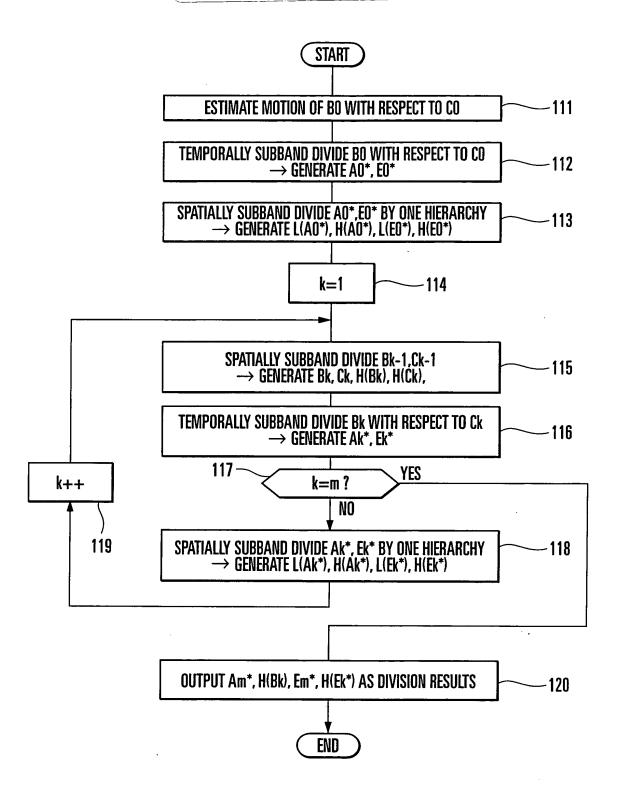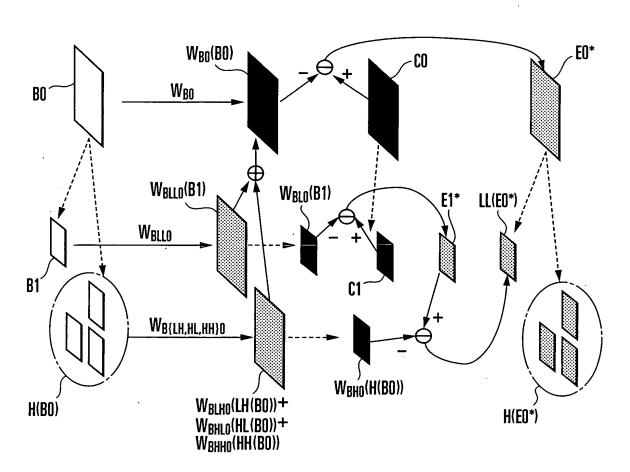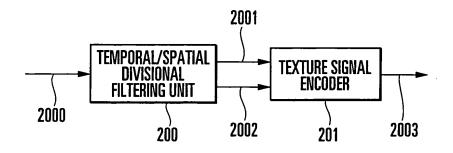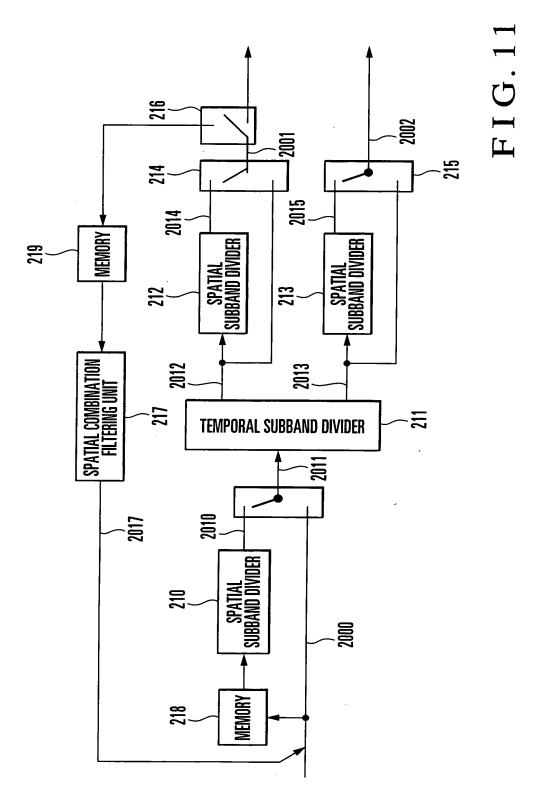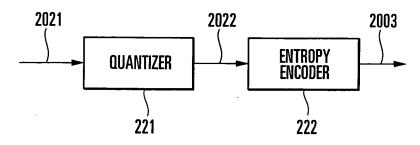SUGHRUE MION, PLLC: 202.293.7060
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$W_{B0}(B0)$

$B0$

W_{B0}

$C0$

$E0^*$

$-$ $\ominus$ $+$

$\oplus$

$W_{BLL0}(B1)$

$W_{BL0}(B1)$

$E1^*$

$LL(E0^*)$

$B1$

W_{BLL0}

$-$ $+$

$C1$

$W_{B\{LH,HL,HH\}0}$

$W_{BLH0}(LH(B0))+$
$W_{BHL0}(HL(B0))+$
$W_{BHH0}(HH(B0))$

$W_{BH0}(H(B0))$

$+$

$-$

$H(B0)$

$H(E0^*)$

F I G . 9

2001

2000

TEMPORAL/SPATIAL
DIVISIONAL
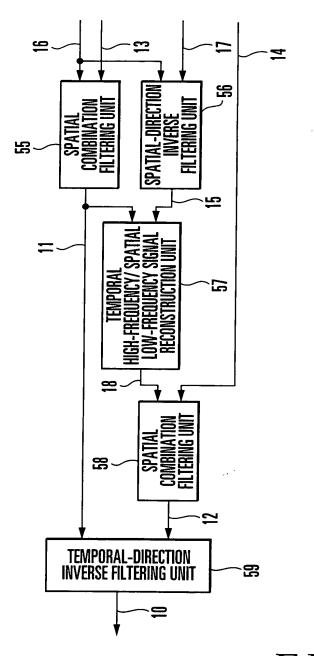FILTERING UNIT

TEXTURE SIGNAL
ENCODER

200

2002

201

2003

F I G . 10

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MOVING PICTURE DECODING METHOD...
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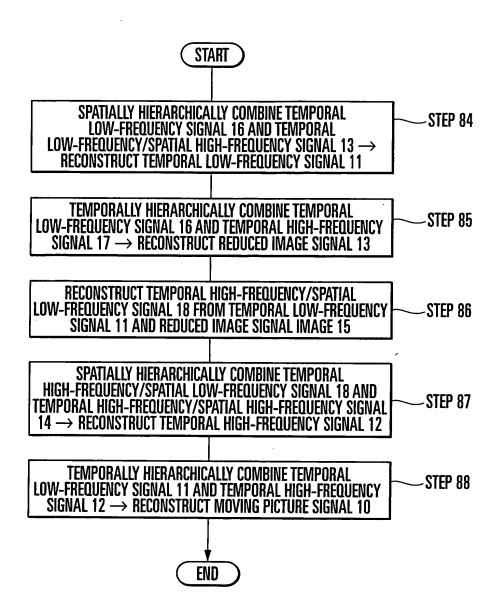SUGHRUE MION, PLLC: 202.293.7060
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FIG. 11

2021 → **QUANTIZER** (221) → 2022 → **ENTROPY ENCODER** (222) → 2003

FIG. 12

16 · 13 · 17 · 14

55 — **SPATIAL COMBINATION FILTERING UNIT**

56 — **SPATIAL-DIRECTION INVERSE FILTERING UNIT**

15

11

18 — **TEMPORAL HIGH-FREQUENCY/SPATIAL LOW-FREQUENCY SIGNAL RECONSTRUCTION UNIT** — 57

58 — **SPATIAL COMBINATION FILTERING UNIT**

12

59 — **TEMPORAL-DIRECTION INVERSE FILTERING UNIT**

10

FIG. 13

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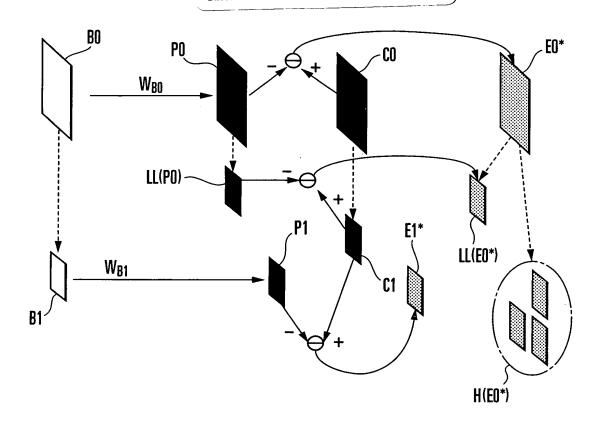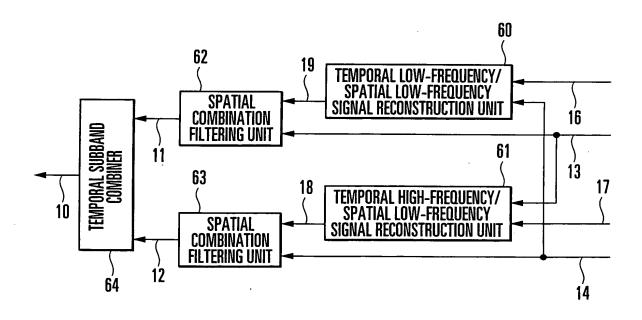SUGHRUE MION, PLLC: 202.293.7060
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(START)

SPATIALLY HIERARCHICALLY COMBINE TEMPORAL
LOW-FREQUENCY SIGNAL 16 AND TEMPORAL
LOW-FREQUENCY/SPATIAL HIGH-FREQUENCY SIGNAL 13 →
RECONSTRUCT TEMPORAL LOW-FREQUENCY SIGNAL 11 — STEP 84

TEMPORALLY HIERARCHICALLY COMBINE TEMPORAL
LOW-FREQUENCY SIGNAL 16 AND TEMPORAL HIGH-FREQUENCY
SIGNAL 17 → RECONSTRUCT REDUCED IMAGE SIGNAL 13 — STEP 85

RECONSTRUCT TEMPORAL HIGH-FREQUENCY/SPATIAL
LOW-FREQUENCY SIGNAL 18 FROM TEMPORAL LOW-FREQUENCY
SIGNAL 11 AND REDUCED IMAGE SIGNAL IMAGE 15 — STEP 86

SPATIALLY HIERARCHICALLY COMBINE TEMPORAL
HIGH-FREQUENCY/SPATIAL LOW-FREQUENCY SIGNAL 18 AND
TEMPORAL HIGH-FREQUENCY/SPATIAL HIGH-FREQUENCY SIGNAL
14 → RECONSTRUCT TEMPORAL HIGH-FREQUENCY SIGNAL 12 — STEP 87

TEMPORALLY HIERARCHICALLY COMBINE TEMPORAL
LOW-FREQUENCY SIGNAL 11 AND TEMPORAL HIGH-FREQUENCY
SIGNAL 12 → RECONSTRUCT MOVING PICTURE SIGNAL 10 — STEP 88

(END)

F I G . 14

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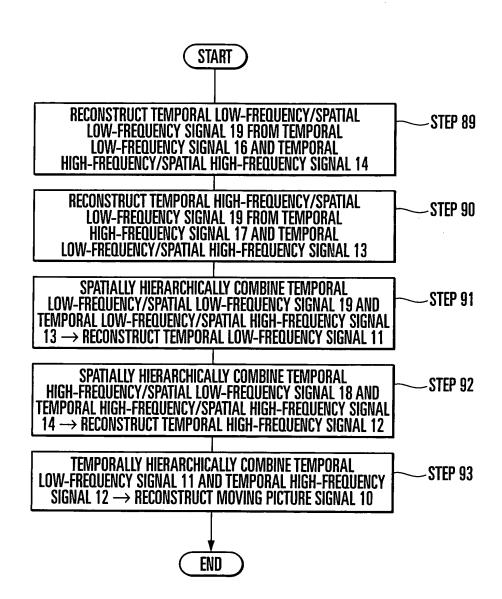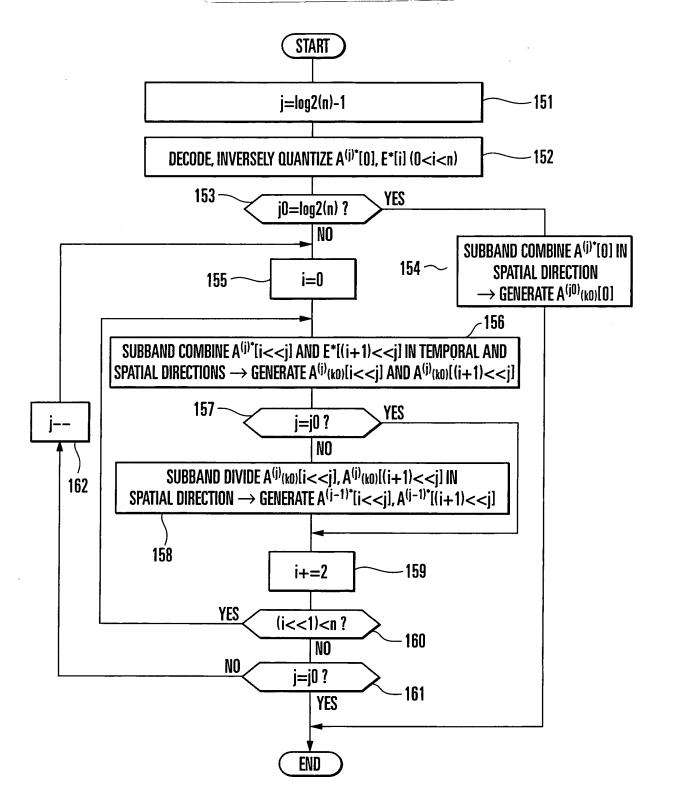SUGHRUE MION, PLLC: 202.293.7060
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F I G . 1 5

F I G . 1 6

START

RECONSTRUCT TEMPORAL LOW-FREQUENCY/SPATIAL LOW-FREQUENCY SIGNAL 19 FROM TEMPORAL LOW-FREQUENCY SIGNAL 16 AND TEMPORAL HIGH-FREQUENCY/SPATIAL HIGH-FREQUENCY SIGNAL 14 — STEP 89

RECONSTRUCT TEMPORAL HIGH-FREQUENCY/SPATIAL LOW-FREQUENCY SIGNAL 19 FROM TEMPORAL HIGH-FREQUENCY SIGNAL 17 AND TEMPORAL LOW-FREQUENCY/SPATIAL HIGH-FREQUENCY SIGNAL 13 — STEP 90

SPATIALLY HIERARCHICALLY COMBINE TEMPORAL LOW-FREQUENCY/SPATIAL LOW-FREQUENCY SIGNAL 19 AND TEMPORAL LOW-FREQUENCY/SPATIAL HIGH-FREQUENCY SIGNAL 13 → RECONSTRUCT TEMPORAL LOW-FREQUENCY SIGNAL 11 — STEP 91

SPATIALLY HIERARCHICALLY COMBINE TEMPORAL HIGH-FREQUENCY/SPATIAL LOW-FREQUENCY SIGNAL 18 AND TEMPORAL HIGH-FREQUENCY/SPATIAL HIGH-FREQUENCY SIGNAL 14 → RECONSTRUCT TEMPORAL HIGH-FREQUENCY SIGNAL 12 — STEP 92

TEMPORALLY HIERARCHICALLY COMBINE TEMPORAL LOW-FREQUENCY SIGNAL 11 AND TEMPORAL HIGH-FREQUENCY SIGNAL 12 → RECONSTRUCT MOVING PICTURE SIGNAL 10 — STEP 93

END

F I G . 17

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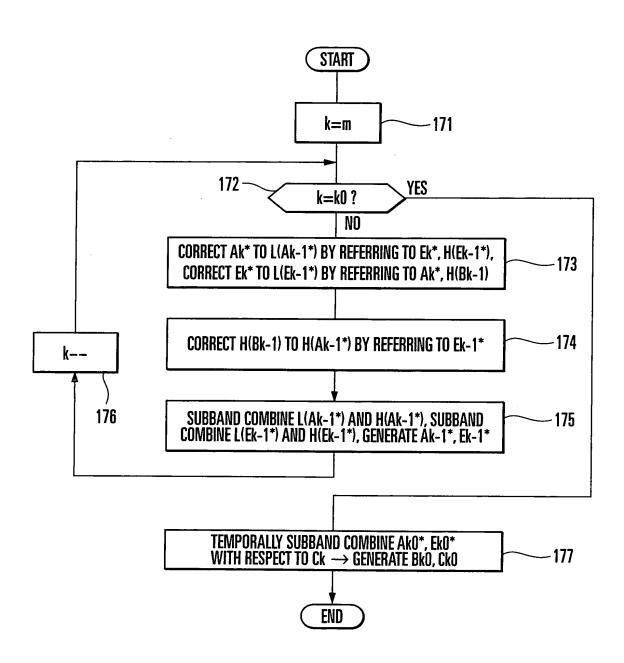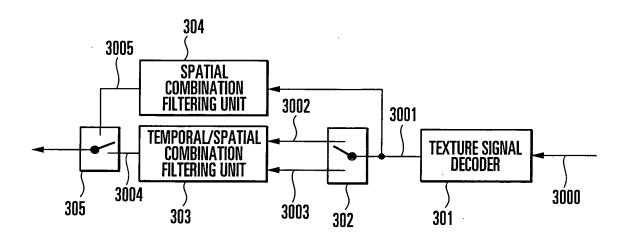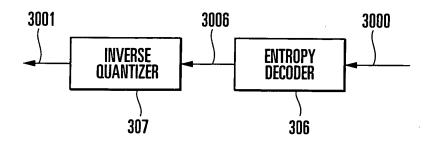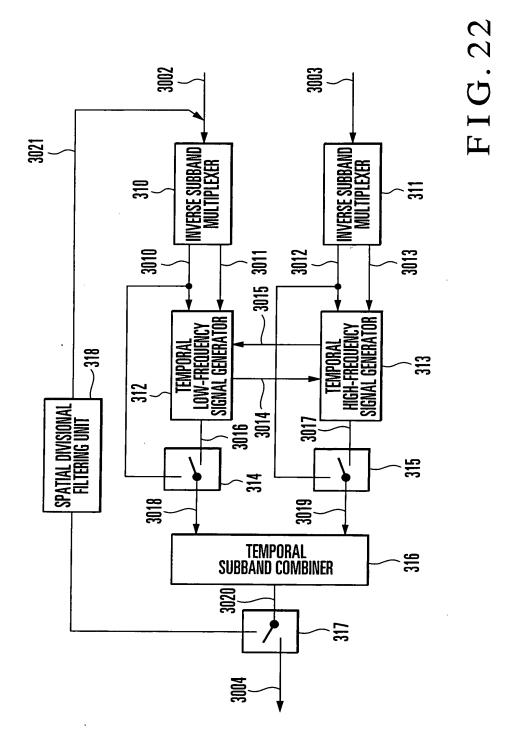SUGHRUE MION, PLLC: 202.293.7060
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START

$j = log2(n) - 1$ — 151

DECODE, INVERSELY QUANTIZE $A^{(j)*}[0]$, $E*[i]$ $(0 < i < n)$ — 152

153 — $j0 = log2(n)$? — YES

NO

154 — SUBBAND COMBINE $A^{(j)*}[0]$ IN SPATIAL DIRECTION → GENERATE $A^{(j0)}_{(k0)}[0]$

155 — $i = 0$

156

SUBBAND COMBINE $A^{(j)*}[i<<j]$ AND $E*[(i+1)<<j]$ IN TEMPORAL AND SPATIAL DIRECTIONS → GENERATE $A^{(j)}_{(k0)}[i<<j]$ AND $A^{(j)}_{(k0)}[(i+1)<<j]$

157 — $j = j0$? — YES

NO

SUBBAND DIVIDE $A^{(j)}_{(k0)}[i<<j]$, $A^{(j)}_{(k0)}[(i+1)<<j]$ IN SPATIAL DIRECTION → GENERATE $A^{(j-1)*}[i<<j]$, $A^{(j-1)*}[(i+1)<<j]$

158

$j--$

162

159 — $i += 2$

YES — $(i<<1) < n$? — 160

NO

NO — $j = j0$? — 161

YES

END

F I G. 18

START

k=m — 171

172 — k=k0 ? — YES

NO

CORRECT Ak* TO L(Ak-1*) BY REFERRING TO Ek*, H(Ek-1*), CORRECT Ek* TO L(Ek-1*) BY REFERRING TO Ak*, H(Bk-1) — 173

CORRECT H(Bk-1) TO H(Ak-1*) BY REFERRING TO Ek-1* — 174

k--

176

SUBBAND COMBINE L(Ak-1*) AND H(Ak-1*), SUBBAND COMBINE L(Ek-1*) AND H(Ek-1*), GENERATE Ak-1*, Ek-1* — 175

TEMPORALLY SUBBAND COMBINE Ak0*, Ek0* WITH RESPECT TO Ck → GENERATE Bk0, Ck0 — 177

END

F I G . 19

304

3005

SPATIAL
COMBINATION
FILTERING UNIT

3002

3001

TEMPORAL/SPATIAL
COMBINATION
FILTERING UNIT

TEXTURE SIGNAL
DECODER

305

3004

303

3003

302

301

3000

F I G . 20

3001

3006

3000

INVERSE
QUANTIZER

ENTROPY
DECODER

307

306

F I G . 21

FIG. 22

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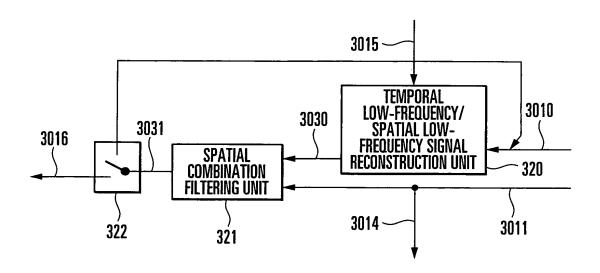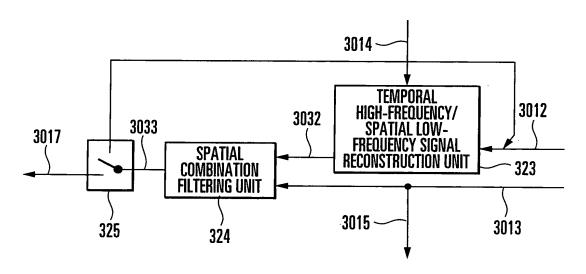SUGHRUE MION, PLLC: 202.293.7060
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3015

3016

3031

SPATIAL
COMBINATION
FILTERING UNIT

3030

TEMPORAL
LOW-FREQUENCY/
SPATIAL LOW-
FREQUENCY SIGNAL
RECONSTRUCTION UNIT

3010

320

322

321

3014

3011

F I G. 23

3014

3017

3033

SPATIAL
COMBINATION
FILTERING UNIT

3032

TEMPORAL
HIGH-FREQUENCY/
SPATIAL LOW-
FREQUENCY SIGNAL
RECONSTRUCTION UNIT

3012

323

325

324

3015

3013

F I G. 24

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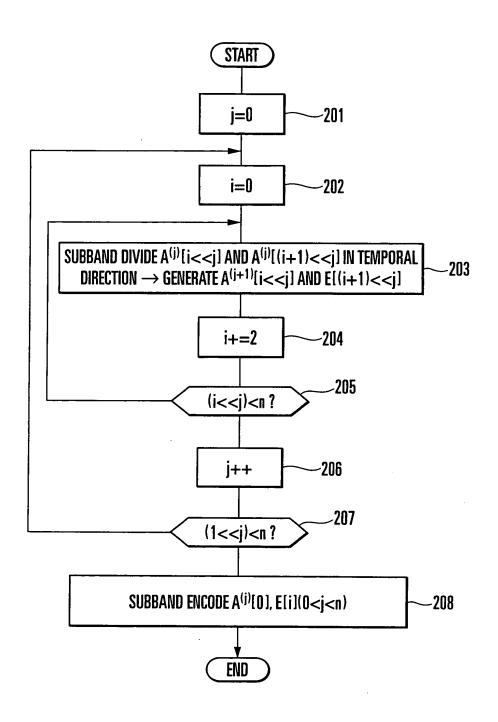SUGHRUE MION, PLLC: 202.293.7060
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START

j=0 ——201

i=0 ——202

SUBBAND DIVIDE $A^{(j)}[i<<j]$ AND $A^{(j)}[(i+1)<<j]$ IN TEMPORAL DIRECTION → GENERATE $A^{(j+1)}[i<<j]$ AND $E[(i+1)<<j]$ ——203

i+=2 ——204

$(i<<j)<n$? ——205

j++ ——206

$(1<<j)<n$? ——207

SUBBAND ENCODE $A^{(j)}[0]$, $E[i](0<j<n)$ ——208

END

F I G. 25

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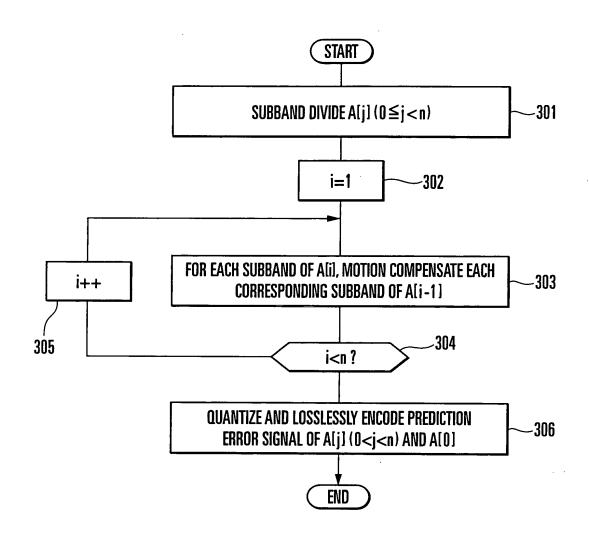SUGHRUE MION, PLLC: 202.293.7060
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START

SUBBAND DIVIDE A[j] (0 ≤ j < n) ——301

i=1 ——302

i++ ——305

FOR EACH SUBBAND OF A[i], MOTION COMPENSATE EACH CORRESPONDING SUBBAND OF A[i-1] ——303

i < n ? ——304

QUANTIZE AND LOSSLESSLY ENCODE PREDICTION ERROR SIGNAL OF A[j] (0 < j < n) AND A[0] ——306

END

F I G. 26